U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

AD-A033 875

TODAY'S WEAPONS - TOMORROW'S REQUIREMENTS

UPGRADING EXISTING SYSTEMS VS NEW SYSTEM DEVELOPMENT - A CASE IN POINT

DEFENSE SYSTEMS MANAGEMENT SCHOOL
FORT BELVOIR, VIRGINIA

MAY 1976

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DEPARTMENT OF DEFENSE SYSTEMS MANAGEMENT SCHOOL

PROGRAM MANAGEMENT COURSE
INDIVIDUAL STUDY PROGRAM

TODAY'S WEAPONS-TOMORROW'S REQUIREMENTS
Upgrading Existing Systems vs
New System Development
-A Case In Point-

CLASS 76-1

by

Charles J. Supko
GS-12 DAC

May 1976

FORT BELVOIR, VIRGINIA 22060

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER	2. GOVT ACCE	RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle)	5. TYPE OF REPORT & PERIOD COVERED
TODAY'S WEAPONS-TOMORROW'S REQUIREMENTS UPGRADING EXISTING SYSTEMS VS NEW SYSTEM DEVELOPMENT - A CASE IN POINT -	Study Project Report 76-1
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s)	8. CONTRACT OR GRANT NUMBER(s)
Charles J. Supko	
9. PERFORMING ORGANIZATION NAME AND ADDRESS	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
DEFENSE SYSTEMS MANAGEMENT COLLEGE FT. BELVOIR, VA 22060	
11. CONTROLLING OFFICE NAME AND ADDRESS	12. REPORT DATE
DEFENSE SYSTEMS MANAGEMENT COLLEGE FT. BELVOIR, VA 22060	76-1
	13. NUMBER OF PAGES 58
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)	15. SECURITY CLASS. (of this report)
	UNCLASSIFIED
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

UNLIMITED

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

SEE ATTACHED SHEET

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

SEE ATTACHED SHEET

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

DEFENSE SYSTEMS MANAGEMENT SCHOOL

STUDY TITLE:

TODAY'S WEAPONS -- TOMORROW'S REQUIREMENTS
Upgrading Existing Systems vs New System Development
-A Case in Point-

STUDY PROJECT GOALS:

The overall goal was to show that the Army's Cost and Operational Effectiveness Analysis (COEA) policy provides an effective avenue in the acquisition process for bringing attention to and comparing an upgraded system with a new system. Specifics leading up to the value of the systems are the delineation of unique problems faced when upgrading a system and the need for systems analysis to reflect the "total" system.

STUDY REPORT ABSTRACT:

By using an actual case history of a program with which the author was associated as a framework, this paper delineates some unique management problems faced by a project manager in an attempt to upgrade his system in the face of a new system.

With problems defined, the project manager's solicitations and rationale to achieve acceptance of system upgrading are presented.

It shows that significant hurdles to system upgrading are generated by subjective and administrative problems which are not usually found in the acquisition of a new system.

The report shows how the project manager confronted these problems and how the Army's Cost and Operational Effectiveness Analysis (COEA) policy provided the avenue for achieving visibility for the potential upgraded system.

The report concludes that: (1) it is more difficult to gain acceptance of an upgraded system than it is for a new system, (2) advanced research and development is as essential for upgrading systems as it is to create new systems, (3) systems analysis must reflect technical and operational considerations for an accurate system assessment and (4) the Army's acquisition policies, in particular the COEA provide channels for bringing forth the acceptance of upgraded systems.

KEY WORDS MATERIEL DESIGN AND DEVELOPMENT REQUIREMENTS MANAGEMENT
PROGRAM MANAGEMENT ROC
TECHNOLOGICAL FORECASTS
KEY WORDS: PRODUCT IMPROVEMENT COEA

NAME, RANK, SERVICE	CLASS	DATE
Charles J. Supko GS-12 DAC	PMC 76-1	12 May 1976

TODAY'S WEAPONS -- TOMORROW'S REQUIREMENTS

Upgrading Existing Systems vs New System Development

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EXECUTIVE SUMMARY

Instead of developing totally new systems to meet future needs, the upgrading of existing systems has received increased emphasis as an alternate approach.

Based upon an actual non-major Army air-to-ground rocket project history, this report addresses a number of management problems that confronted a project manager who was attempting to gain recognition of the potential of an upgraded version of his system as a viable alternative to a replacement air-to-ground rocket system which was being pursued in the development laboratories.

Significant areas impacting on the acceptance of an upgraded system instead of a new system were defined as; user impression/perceptions of the existing system, system reputation, requirements determination, requirements documentation, advocacy of the project manager, and systems analysis methodology.

The report proceeds with discussion of how the project manager addressed each area. The discussions show how these areas take on significant and sometimes subtle differences and implications just because the system is being upgraded instead of being a new system. In this particular case, the Army's Cost and Operational Effectiveness Analysis policy, acting as a checkpoint in the acquisition cycle, became the major influencing factor in the decision making process.

The report concludes that, although Army policy cites evolutionary development as a preferred method of acquisition, once a new replacement system had been defined, acceptance of an upgraded version of the existing system was only achieved through the requirements set forth by the COEA regulations. The COEA provides a final opportunity for any competing alternate system (especially an upgraded system) to be evaluated before a final commitment is made within the Army.

ACKNOWLEDGEMENTS

The author wishes to express grateful appreciation for the encouragement and suggestions offered by LTC Bill Chen and to other members of the DSMS faculty for their thoughts regarding the subject of this report. To the staff of the DSMS library for their assistance the author is grateful. And to my wife, Nancy, a special word of appreciation for her patience and assistance in typing this report.

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SECTION I

INTRODUCTION

The past several years have been a period of continuing effort on the part of Congress, Department of Defense, and industry in examining the causes of problems in the acquisition of DOD systems. These problems are reflected in escalating costs, slippages in development and deployment schedules and in fulfilling performance capabilities. Numerous new policies and management techniques have been proposed and in many cases put into effect.

These efforts have sparked a renewed interest in prototyping of hardware and a return to a "fly before buy" concept. This is intended to prevent over-sophistication in hardware and to facilitate the production of systems at an acceptable cost.

As part of the overall process to improve the efficiency, effectiveness and potentcy of the acquisition process, additional emphasis is being put upon prolonging the usable life of existing systems; upgrading systems to meet current and projected needs and shifting the role of existing systems to extend their usability. Basic DOD policy calls for consideration of using existing systems.

> In the plan for evaluating system alternatives, consideration is to be given to all approaches that appear to be technically feasible, operationally practical and economically affordable (i.e., includes modifying existing defense systems (or variants) under

development by other DOD components, developing a new system, or employing a foreign-developed system) (5:3).*

The premise that existing or modified systems can satisfy our future needs has been expounded in the halls of Congress. The current most volatile issue of this nature concerns the utility of the Air Force's existing B-52 bomber vs development of the supersonic B-1 bomber.

It appears that the issue of upgrading existing system versus initiating new system development will continue to receive high visibility.

PURPOSE

The purpose of this report is to focus attention on some of the issues which faced an Army Project Manager of a non-major system in attempting to gain acceptance of the fact that future requirements can be satisfied via upgrading an existing system and see how he confronted them.

It will be shown in at least this particular case that the Army's Cost and Operational Effectiveness Analysis (COEA) requirement, prior to full-scale development, was an effective avenue and checkpoint in the acquisition process to gain recognition that an upgraded system can satisfy requirements for the future.

SPECIFIC GOALS

By using an actual case history of a program which the author was associated, this report will show that a project manager trying to gain acceptance of an upgraded system

*This notation will be used throughout the report for sources of quotations and major references. The first number is the source listed in the bibliography. The second number is the page in the reference.

encounters difficulties that he would not have encountered if he was promoting a new system. By using this case history approach to highlight some of the unique problems, this report will establish that the decision-making process, in order to select the best approach, must be supported by systems analysis that correctly identifies the "total" system and not a sub-optimized subsystem.

The value of the Army's Cost and Operational Effectiveness Analysis will be demonstrated via this case as an effective means within the acquisition process of achieving visibility for the potential of an upgraded system as compared to a new system.

SECTION II

CASE DEVELOPMENT

Background

During the conflict in Southeast Asia the need arose to provide Army Aviation with increased firepower and capability. The capability had to be achieved rapidly.

To satisfy this requirement, it was determined that a Korean War vintage air-to-air free-flight rocket could readily be adapted to Army helicopters in an air-to-ground role.

As use of this project managed rocket expanded, demands for the rocket also increased precipitating the establishment of a large production base. In conjunction with this expanded use and production, the project manager pursued a course of product improvement of the system in response to the aviation community's needs. Improvements of warheads, fuzing, motors and launchers were made.

Thus there was a resurrection of a system and the initiation of a growth and evolutionary process.

Transition to Research and Development

System evolution and growth through product improvement programs is basically a short-range view point aimed primarily at resolving existing operational needs. Funding for such improvement programs is closely linked with production.

Long-range planning and development however drives the program into the research and development phases of the of the acquisition cycle. This is precisely what transpired. An obsolete system was called upon to meet an operational need; it was put into mass production and then strode into the relm of research and development.

Prudent development of a tried and proven air-to-ground free-flight rocket appeared to be a course that would be desirable. However this was far from reality. When an existing system attempts to enter the advanced or engineering development phases of the acquisition cycle it must be proven that this is the correct step.

The problems, difficulties and issues that arise in attempting to convince all participants of the system acquisition cycle that an already fielded system has sufficient growth to meet tomorrow's requirement are overwhelming.

John S. Foster, former Director, Defense Research & Engineering, OSD addressed the dilemma:

> One of the most critical problems we face is making the decision to initiate orderly development of a weapon system.
>
> ....The decision rests in questions that are complex. These questions involve the character and timing of present and possible military threats with which we may have to cope. Such threats are developed in secrecy and often revealed to us only at late stages. The question involves the extent to which we believe these future threats can be countered by our present weapon systems, and how effective the proposed new system might be.
>
> This involves the difficult projection of confidence in technologies proposed for the future system. (7 :239)

SECTION III

ISSUES CONFRONTING THE PROJECT MANAGER

This section establishes particular issues that were faced by the project manager as he proceeded with the task of attempting to achieve acceptance of upgrading his existing system. These issues are by no means the only ones that had to be faced. They were issues that were of continuing influence, thus requiring almost constant attention and concern.

User's Impression/Perceptions

Within the Army acquisition process the user (combat developer) has the primary role in defining future requirements. The material developer responds to the needs of the user. Without user concurrence it is very unlikely that a program would not proceed very far through the acquisition cycle. This is even more true for non-major programs. Such programs are funded after the major priority programs. There is very little if any at all "top-down" pressure pushing them. Thus the user must be an active supporter. His support must be cultivated and preserved.

Stigma of Age

A fielded system is one that generates proponents as well as opponents. The perception of the systems merits and potential is invariably bound to attitudes and values. In a decade, or more likely a generation, of rapid technological strides, the perception of being a warmed-over relic is a significant obstacle that demands recognition.

The question inevitably is asked; "how can such an old system (i.e. Korean War vintage) be suitable in the late 1980's?" The individual who will eventually be using the system demands to have the most modern equipment possible. This is not unique in the world of weapons; it is an American characteristic; i.e., strive for the most up-to-date model possible. There are constant and tremendous forces calling for modernization.

Vice Admiral Hyman G. Rickover, U.S. Navy, Director, Naval Nuclear Propulsion Program addressed this in 1971 testimony:

> ...If the investment for our future needs is not met now, there may be no future.
>
> ...In the Vietnam war, we have managed to sustain ourselves by using up a great deal of material, drawing down our reserve stocks, wearing out much equipment...
>
> ...It seems clear to me that, considering recent history, it is dangerous to proceed into the future with our strength declining while that of our potential enemies is increasing. (13:340)
>
> It (development strategy) encourages the services to include in a basic new weapon system all the improvements in various components that have been developed since the last system... This not only results in loading down major systems... but also militates against having the option available of making incremental improvements in old systems rather than starting all over again. (13:6)

This is the crux of the problem. The rocket system that exists today and that which is planned for the future is a far, far cry from the day it was first flown in Vietnam. Yet it is still perceived as it was when it was first issued. True, the name is the same and the overall basic configuration is relatively unchanged, however, the capabilities and performance levels are drastically better.

Those who are in Army aviation have seen radical changes in the appearance, names and performance of their aircraft, as well as the introduction of guided missiles for point targets.

Thus the rocket system is immersed in an environment of visible change and is plagued with the perception of being outdated. This perception regardless of its foundation has been a hurdle which must constantly be addressed as the system bids for a role in tomorrow's arsenal.

On the other hand, any proposal for a new free-flight rocket system does not have to overcome this hurdle. It is fresh from the laboratory - laboratories that have delivered the latest in air-to-ground missiles. Wouldn't the new one have a much longer life than an upgraded old system?

System Reputation

A system's reputation is a main contributor to how it is perceived. A project manager is always concerned with the reputation of his system. Reputation can make or very easily break a system. A very fragile yet enduring commodity is reputation. In an instant it can be created and a life time can be spent explaining it.

When the rocket system was introduced again into active service no one ever imagined that it would be looking for a future in the 1980's and 1990's.

As rockets were used at ever-increasing rates a reputation began to emerge. There were those reputations that were positive such as being known for being able to deliver high firepower and for effective area neutralization. Then there were the reputations that decried that rockets are inaccurate i.e., they cannot hit the broad side of a barn. With the passage of time, rockets became to be known to be effective only at short ranges of approximately 2000 meters.

As with any reputation there is little if any questioning of the validity of broad generalized statements. Regardless of how often they may be explained there is always someone who will never let erroneous matters die. Take the two points accuracy and range mentioned above for example. First, the rocket system is an area suppression/neutralization weapon never designed to have a single-shot capability against point targets. When inaccuracies are discussed never is it portrayed in terms of necessary flight profiles needed to assure a proper flight trajectory. Like any ballistic item, a free-flight rocket goes where you point it. It is sensitive to the angle of fire. That is why rifles have adjustable sights and artillery pieces are precisely set. Now just consider the impact of a vibrating helicopter as a firing platform and you can imagine what might happen.

Regarding range limitations, the Vietnam scenario for attack helicopters was to begin a delivery attack at approximately 2500 meters. Thus pilot training and manuals depicted such a delivery mode. There was really no training to fire at ranges of 5000 meters which was possible because there was no need. How can you untrain those pilots? It is to be expected that they would be skeptical when told that the system they once flew can easily meet the future needs of 4000 and 5000 meters. All his training and experience have set in his mind a reputation which as far as he is concerned is factual.

Impressions and reputations became an additional hurdle for upgrading a system.

New systems on the other hand do not have such hurdles. In fact, new systems capitalize upon the user's impression and negative reputation of an existing system to generate support for themselves.

REQUIREMENTS

Requirement Determination

Requirements determination, a specific part of the systems acquisition planning process, deals with the identification of operational requirements for new weapon systems. It is considered by many experts to be the most critical problem faced by OSD. John Malloy, Director of Procurement, OSD, testified that "the major problem in procurement of complex weapons systems is that of adequately defining the requirement." (7:15)

With the sixties and seventies came the emergence of the buildup of the Soviet armor forces. In response, requirements focused on the armor threat. This threat spawned an era of weapons such as TOW, DRAGON, HELFIRE and CLGP all dedicated to defeating individual point targets.

Scenarios were structured, war games generated, all focusing on the very real and dominant armor threat. I am by no means implying that the threat is not valid or that the cited weapons are not required. My point is that it is extremely difficult in such an environment to talk in specific terms of area neutralization weapons.

I must offer a reminder that I am talking in the realm of Army aviation. Other areas may very well have an excellent grasp on their needs regarding area suppression weapons. Army Aviation however generally accepted that area suppression weapon systems are needed but quantification is another matter.

To proceed into the development of an upgraded rocket system it is essential that the requirement be determined in terms of means to satisfy the requirements.

> The concept that requirements can be written as a statement of need that is independent of the means to satisfy the need is unsound. It leads to requirements being stated either in terms of rigid, immutable desires or in terms of things, not capabilities. The result has been inflexible requirement statements that make no provision for changes in threat, technology, or tactics; inhibit initiative and imagination in development; and often result in costly contract changes and overruns. (3:4)

A new system has much more flexibility in that it can develop a requirement in terms of surpassing the existing system rather than the upgraded version of the existing system. In this manner the existing system never is justly evaluated. A draft Required Operational Capability (ROC) for a new rocket system was generated. Its main feature was that the new system was to replace the existing system because the existing system did not have the range or accuracy required for future battlefields. It used as a baseline the existing rocket as opposed to the upgraded version of the existing system.

However, evolutionary development is the stated preference by the Army:

> The Army's materiel needs are generally satisfied through three methods--buying equipment already developed (commercial--domestic or foreign; military--other Services or allies), evolutionary development of current standard equipment, or initiation of a new materiel development program. The preferred method to correct inadequacies in already developed systems is to exploit the performance growth potential inherent in those systems. Materiel system design will emphasize simplicity, austerity, and supportability, with planned growth potential to accommodate anticipated

future needs when the additional cost for such growth potential can be justified. The Army must plan for evolutionary development over the entire life cycle of a system. Combat and materiel developers will assure the timely, cost-effective exploitation of unrealized growth potential of materiel systems to satisfy the Army's materiel needs. (1 :1)

The way in which the requirement for a new system was stated did not recognize the growth potential within the existing system. Thus the project manager of the existing system was confronted with a requirement which was formulated by the user and laboratories, which implied that the existing system could not satisfy the operational needs.

Requirements Documentation

In order for a project to proceed into development it must be supported by an approved requirements document. This is essential. However, it can become a nightmare when a system is attempting to be upgraded. I am only referring to a non-major system which puts a slightly different light on the process. The non-major program usually does not receive priority pressures. The guidance for the upgrading process was that each facet that was planned to be improved would have its own independent requirements document. In this particular case, a family of warheads was being proposed to upgrade the system. Rather than structure an improved system document, each warhead was broken out separately and had to go through the same process as if it were an independent system.

The rationale was that a possible replacement system was being pursued so rather than commit totally to upgrading the existing system or jump into a totally new free-flight rocket system, an incremental approach was decided upon. This would allow for funding of those areas within the existing system that could be readily transferred to the new system should these areas prove to have merit.

This was a prudent and cautious approach. It allowed for examination of each system. However, it put upon the existing system a large administrative burden of multiple requirement documents whereas the proposed new system was operating under an overall system draft requirement document.

The project manager was faced with determining which would be the best strategy for these documents. Should they be structured as Letters of Agreement (LOA's) or Required Operational Capability (ROC) documents. Since all of the upgrading efforts drew extensively from an existing technology base the distinction between advanced development supported by an LOA or full scale development supported by a ROC would be difficult.

In addition, with separate documentation, the loss of a system perspective throughout the organizational structure of the Army was a matter of concern to the program office.

ADVOCACY

"It has been said that a man's career can rise or fall depending upon his ability to sell his project." (12:41)

Program managers have been known to say:

> The program manager's main job is to make the program look good. I don't mean to fake it. I mean to be on top of the program, to anticipate what the boss expects, what the budget people expect, what OSD expects, and even what Congress expects. The image of an energetic, capable program is a great asset in recruiting the people you want in the program office, and in obtaining the right kind of support from functional organizations. The morale and success of the program office staff are largely a reflection of that image. A good image results in cooperation and a bad image results in struggling all the time to get what you need. The program manager has to be the outside man -- the salesman, if you wish to call him that --. (4:44)

Advocacy is a fact of life for a project manager. He is expected to be an avid supporter of his project. However, there is a subtle difference in how advocacy is perceived. This perception is closely related to the phase of the acquisition cycle in which the project exists.

Advocacy is usually associated with the introduction of a new project.

Systems advocacy in the early phases of acquisition is generally recognized and defended within the services. The Services consider the new project office as a resource which is alert to technological advancement possibilities which will be presented to the decision makers. The permeating underlying assumption is that technology development is the vehicle through which our national security interests and security will be maintained.

"The whole point of the development process is to get something that we haven't got, something that we have never seen, and something that we don't really know can be produced." (7 :2493).

The emphasis on developing all elements of a system as part of a single development project encourages the services to include in a new system all the improvements in various components that have been developed since the last system.

On the other hand, when a system has already been deployed and could possibly be phased out, a project manager's advocacy is equated with defending the project from obliteration. "How are you going to deal with a project manager who is in a position of having to defend a project... (doesn't) he become the advocate of the project?" (8 :195)

There is a natural tendency to equate such advocacy with self-preservation His objectivity and that of those around him is questioned.

To draw an analogy, consider how you would feel regarding the enthusiasm of a salesman trying to sell you a new car as opposed to an enthusiastic used car salesman. Would you not be more cautious of the used car salesman?

A project manager must recognize that his advocacy will be perceived very differently just because his program is not a new program.

He is faced with a very serious problem of structuring and projection of his advocacy and enthusiasm.

Advocacy is an issue which by itself can destroy any consideration of upgrading a system to meet future needs and this must be recognized by the project manager. There has been and will in all likelihood continue to prevail an overall feeling that project managers are overly concerned with the packaging and appeal of their project.

SYSTEMS ANALYSIS

When you come right down to the heart of the acquisition process you are really concerned with the decision making process. Every system whether it be a new one or an existing one trying to satisfy a future need is actively seeking that statement of approval.

So far the issues raised have been concerned with the nonquantative subjective nature of a program manager's environment. Although such topics influence the decision making process, decisions are to be made upon objective criteria.

With the development of computer technology and quantatative analytical techniques the value of system analysis has risen to a dominant position. Analytical information developed through simulation is the main stay of the objective aspect of the decision making process.

For the case situation around which these discussions center, system analysis became the most crutcial factor to be faced by the project manager.

He found himself in a position of constantly defending the performance of his system. Generally the controversy was divided into two major areas. These areas were accuracy* and effectiveness. (*Accuracy is measured in milliradians of dispersion around the aim point).

Proponents of the new rocket system were basing their development effort on the basis that the existing system did not have sufficient accuracy to satisfy the long range requirement of future battlefields. A primary objective of their development programs was to significantly reduce the ballistic dispersion of the rocket thereby improving its accuracy. The development program was able to show that the new rocket did indeed achieve a ballistic dispersion that was markedly less than that of the existing system.

From an effectiveness point of view the new rocket was able to develop a larger lethal area than the existing rocket. This was primarily due to the fact that the new rocket was almost twice as large as the existing one.

With these parameters (accuracy and effectiveness) in hand, a system analysis would be applied.

Basically, the analysis would: (a) assume the target, (b) assume the range to the target from the aircraft, (c) fire a rocket, (d) apply the rocket's ballistic dispersion, (e) predict the number of rockets required to achieve a particular level of casualty. This type of analysis was applied to both the existing and propcsed new rocket system. The results of such an analysis showed that the new system required far less rockets to achieve a particular level of effectiveness than that required with the existing system.

The new rocket system appeared to be the way for the future. The problem was however that the analysis was a ballistic analysis not a weapon system analysis. The weapon system includes the pilot, the aircraft and then the rocket system.

The project manager considered the analysis to be a suboptimization rather than an accurate portrayal of either the existing or new system. He was thus confronted with the major issue of getting the analytical community to use a reasonable methodology.

The project manager was of the opinion that a systems analysis which reasonably represented the entire aircraft/weapon system would show that a very accurate rocket was not compatible with a helicopter launch platform.

Critics of the acquisition process have been taking a hard look at performance requirements especially in today's environment of high unit costs.

"Over the years there has been increasing criticism of the DOD weapon system acquisition process because critics believe that most if not all, systems were overly sophisticated and designed to performance requirements that were not needed." (6 :6)

Thus the project manager of the existing system was confronted with the analysis methodology which he believed to be inappropriate for helicopter launched air-to-ground free-flight rockets. Yet this type of analysis was being used in the decision-making process.

SECTION IV

PROJECT MANAGER CONFRONTING THE ISSUES

The previous chapter brought into focus a number of issues that confronted a project manager who was attempting to demonstrate that an existing system if upgraded can satisfy the future requirements for air-to-ground rockets. The issues presented were not intended to be all inclusive. They were selected because of their persistance and impact.

Each had to be addressed and resolved if there was to be any hope of continuing with an upgraded system. This section takes those issues and shows how the project manager confronted them.

User Impression/Reception

Stigma of Age

How does a program respond to combat developers who ask why would an old system when upgraded be capable of meeting future requirements ?

Since the rocket had undergone a number of product improvements in the areas of warheads, fuzing, motors, and launchers, it was a far better product than it was when it was first adopted for helicopter use. Therefore, the initial endeavor was to attempt to ascertain why the user still considered the rocket system to be an antique.

In a rather short period of time, primarily through meetings, conferences and discussions with the various elements of the user community a pattern began to emerge as to why the rocket was still regarded as an outdated product.

Within the structure of the combat developer the underlying basis for the opinions was predominantly traceable to the actual Vietnam experiences that the now senior officers had when using the rockets. The majority of these officers were exposed to the rocket during its early introductory phases. They were well aware of the shortcomings of that system.

In many instances these officers were involved in pushing for the various product improvement programs. However they tended to view the previous product improvements programs as an upgrading of the system just to make it compatible with a helicopter air-to-ground environment without really changing the basic characteristics of the system.

In an overview sense, they were correct. However they tended to regard the proposed upgrading plans in the same light. This was a gross oversimplification and incorrect. The proposed program was dominated by major advances in warhead technology. Warhead technology that used the basic characteristics of the rocket to improve the performance and capability of the entire aircraft weapon system.

Thus the situation became one of not only developing a dialogue with the user but one of developing the correct dialogue. A dialogue which portrayed the proposed upgrading in terms of specific warhead technological advancement as opposed to a general overview. This became an extremely important approach because the proposed replacement of the existing system was using the basic warhead technology that existed in the current system. Their (the proposed new system) approach was to apply motor technology to reduce ballistic dispersion. This coupled with a larger size was presumed to be the best approach.

The natural question is to ask why not develop a rocket system that combines both the warhead and motor technology. This will be addressed in the following sections of "Advocacy" and "Systems Analysis."

It was recognized that past experience was not the only reason why the user community maintained his image of antiquity about the existing system. Careful consideration was given to defining the information sources which the user relied upon for his input. Not surprisingly the sources were defined as particular in-house R&D laboratories and contractors advocating replacing the current rocket system with their more "accurate" and larger rocket system. They were basing their comment on the systems analysis cited in the previous section.

Note: It must be remembered that at this point the program office was just trying to make the transition from its primary production responsibility with its associated communication channels to a research and development mode of operation with its channels of communication. Consequently neither the development labs or contractors were really familiar with the project office's concern over the analytical methodology.

Each had a well established channel of communication with the combat developer at all levels. Of course, on the material developing side of the house the labs also had well established communications and a credible reputation.

It was soon realized that the "stigma of age" was being perpetuated by the laboratories and contractors because they were utilizing very old technical data of the existing rocket system. In fact it was discovered that revised data had not yet been published and that it would be a considerable time before the data was published through the standard system.

To reduce or hopefully eliminate the continuance of being considered an antique the motivating factors of both industry and the in-house labs were considered.

Part of the problem has been recognized for quite a while.

> In the absence of a highly developed arsenal system, the leading contractors represent the backbone of the scientific, engineering, and manufacturing capability to design and produce weapon systems and the Government becomes locked-in or dependent upon them. Thus a symbiotic relationship develops where the defense industry becomes dependent on military orders and the defense establishment primarily looks to these companies for the development of its new weapon systems. (9 :247)

> The main motivation, overwhelming everything else, is survival, and in an environment as turbulent

> as defense contracting was during the 1960's, what you need to do to maximize your changes of surviving is quite different from close cost control on individual contracts.
>
> The sine qua non of survival for major system suppliers is winning new development contract awards. (13:134-135)

The approach taken by the program office was to very deliberately develop lines of communication within the user and material developer research and development community as well as with contractors interested in air-to-ground rocketry.

A policy of rapid and accurate responsiveness was established. Within the program office specific individuals were designated as responsible for particular development efforts. They were to be held responsible for assuring that the current and accurate data was disseminated.

The project manager was well aware that the decision as to which system would see the future was not his. His objective was to do everything possible to assure that the decision makers received the most credible information possible and that he was getting the data he needed regarding the proposed new system to properly comment upon and challenge.

Systems Reputation

Recognizing that the range and accuracy reputation of the rocket system were prime drivers behind the user's desire for a new system and reluctance to accept the upgrading approach, the project manager concluded that the user had to play a major part in correcting these misconceptions. To begin with it had to be shown conclusively that when one talked rocket system performance one was actually adressing the total aircraft and rocket weapon system. In this regard the project manager was confident that the accuracy reputation attributed to his rocket was greatly influenced by parts of the total aircraft weapon system over which he had no formal control.

When the rocket was pressed into service, the data base describing the accuracy of the rocket when launched from a helicopter was essentially nonexistent.

Without a sound data base the project manager could not support any position he might take nor could he refute the user's claims and most significantly he could not assess any proposed developments with confidence.

As a result a program which heavily involved the user and analytical community to establish an error budget for the complete aircraft weapon system was formulated. The program was known as the Baseline Accuracy Test.

The Baseline Accuracy Test defined the system in terms of range to target, pilot range estimation errors, aircraft flight attitudes, interface between the aircraft and weapon, influence of weapon launch on aircraft attitude for successive launches, rocket trajectory and relative wind.

Table I is an example of the type of data that was developed by the Baseline Accuracy Test.

The results showed that pilot range estimation error was the major source of total system inaccuracies. Incorrect range estimation errors resulted in the pilot assuming the wrong launch attitude producing significant miss errors. On the average a pilot's range estimation error was ± 20%.

Even without range estimation errors rocket dispersion errors were shown not to be a dominating factor in the error source (Table II).

In addition to improving the rocket system reputation this program had a number of other major outcomes. First, it provided a basis for correcting the improper reputation attributed to the rocket. Second it provides a basis for significantly improving the analytical methodology used in system analysis. Third, it was an important factor in supporting a requirement to develop an on-board fire control system (Fig 1) "to integrate existing and follow-on aerial rocket and gun projectile ballistic data with the aerodynamic efforts of the launch environment and range to target." (15: 1) Fourth, it went a long way in establishing the credibility of the project office in the research and development community.

With the Baseline Accuracy Test behind him the project manager was ready to confront the next major detrimental reputation of the rocket. That reputation was that the rocket

		Range Sigma (mils)	Deflection Sigma (mils)
(1)	Aircraft Velocity	.19	0
(2)	Aircraft Altitude above Target	1.13	0
(3)	Helicopter Pitch Angle (Relative Wind)	1.93	0
(4)	Helicopter Pitch Rate	.13	0
(5)	Helicopter Yaw Rate	0	.55
(6)	Launcher Pitch Angle	.26	0
(7)	Launcher Pitch Rate	.90	0
(8)	Total Pitch Rate (Helicopter & Launcher)		
	Actual	.90	0
	Gross	1.0	0
(9)	Launcher Max Pitch Diff		
	Actual	.16	0
	Gross	.19	0
(10)	Launcher Max Pitch Rate Diff		
	Actual	.17	0
	Gross	.45	0
(11)	Launcher Yaw Angle	0	.29
(12)	Launcher Yaw Rate	0	1.10
(13)	Total Yaw Rate (Helicopter & Launcher)		
	Actual	0	1.59
	Gross	0	1.71
(14)	Launcher Max Yaw Diff		
	Actual	0	.27
	Gross	0	.29
(15)	Launcher Max Yaw Rate Diff		
	Actual	0	.49
	Gross	0	1.00
(16)	Helicopter Relative Wind (Yaw)	.03	10.88
(17)	Dive or Climb Angle (Relative Wind)	4.77	0

NOTE: The actual data values inputted to the analysis method for Flight 6B2 are recorded in Annex A, Table A-2.

TABLE I -- Effect of Error Sources During Flight 6B2

(11- _)

ERROR SOURCE	STANDARD DEVIATIONS OF ERROR SOURCES (MILS)	
	Range (Pitch)	(Deflection)
Relative Wind	4.6	10.0
Aim Error (Pair Flights/Known Range)	6.5	7.4
Rocket Dispersion		
Pairs	5.8	8.9
Launcher Vibration	1.0	1.0

TABLE II

(11:__)

was only a short-range weapon. Not only was the case made analytically but again the user was heavily involved. In this case rockets were provided to the user to develop new Nap-of-the-Earth tactics with rockets at long ranges out to 5000 meters. Supported by the Baseline Accuracy Test, predictions were confirmed by user testing.

It was a slow process. The results, however, produced a gradual acceptance among the user community that the previous reputation of accuracy and short range were gross assumptions and that a credible data base now existed for further analysis.

This section shows that a project manager can correct, protect, and develop his system's reputation. The biggest asset he has in this crusade is hardware. He will have to demonstrate every claim he makes.

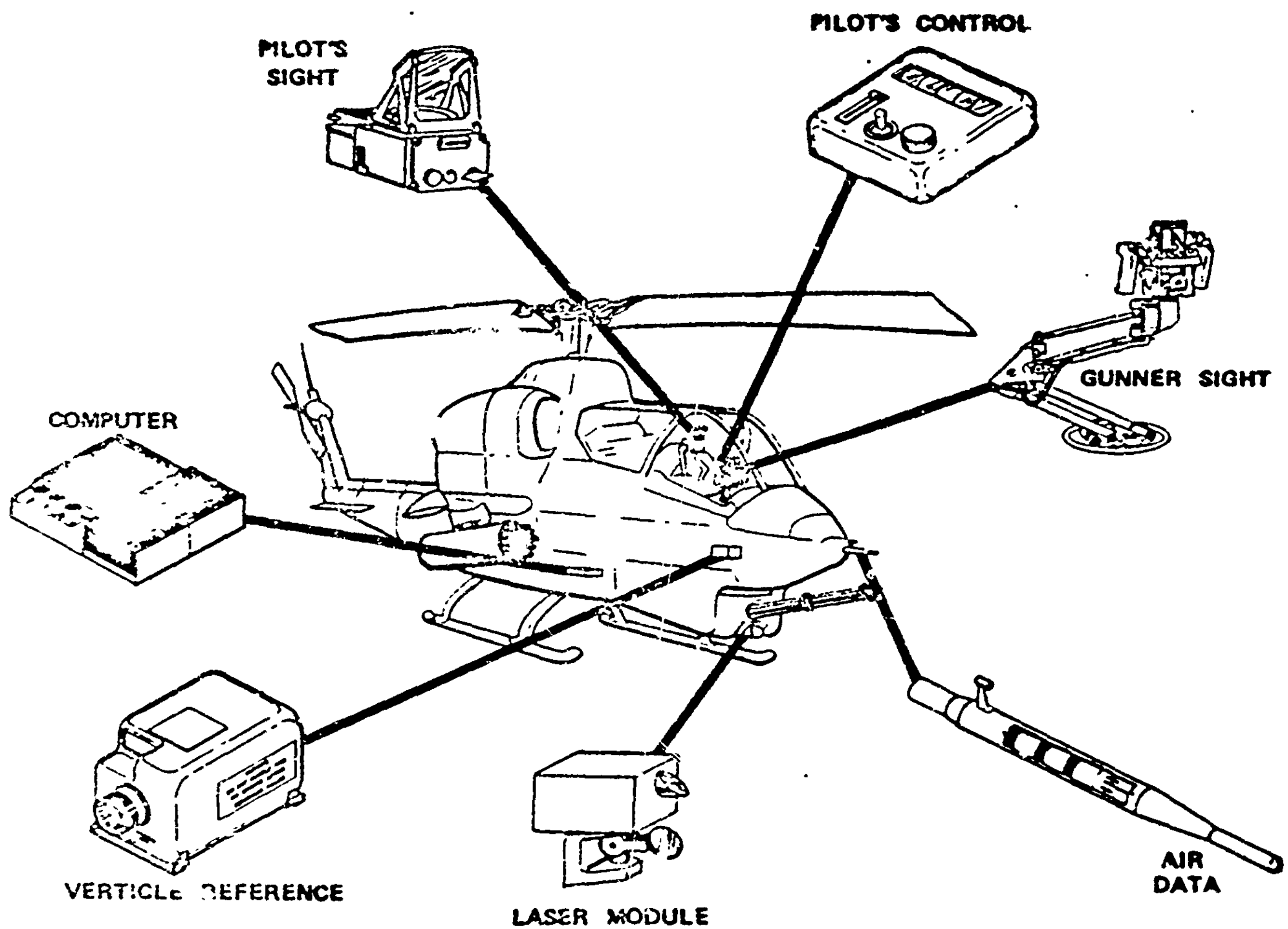


FIGURE 1 FIRE CONTROL SYSTEM (10:31)

Requirement Determination

Determining the requirements for the upgraded version of the existing rocket system was not a simple matter. There was general agreement between the program office and the user that the existing system would not satisfy future needs.

The first attempt was to structure the requirement in terms of an upgraded system. As this proceeded it became obvious that the requirement was similar to that of the proposed new system, which was already receiving advanced development funding.

The decision was made to take the overall threat and form subdivisions to develop requirements for the individual warheads of the upgraded rocket system.

This approach offered a number of advantages over a total upgraded systems approach. First, it was not an obvious duplication of a requirement that was already being staffed. Second, it focused upon particular technological areas. This would allow for incremental funding of high interest areas. Third, it allowed the user to establish priorities for his needs. The result was the formalization of a requirement for a (1) smoke warhead, (2) submunition warhead, (3) illumination warhead, (4) chaff warhead, (5) light-weight launcher and (6) remote set fuzing. (Note: Light-weight launcher and remote set fuzing were initially started under a product improvement program.)

From the Department of the Army's view, this allowed them to look at both motor technology being developed by the new rocket system and warhead technology proposed as an upgrading of existing system with the possibility of later combining the technologies.

Requirement Documentation

To establish a documentation strategy for upgrading the existing system it was necessary to consider the Army development documentation criteria. The development of a particular strategy and also required coordination with the Training and Doctrine Command (TRADOC) and the Army Materiel Command (AMC) in deciding if the LOA or ROC route was applicable and acceptable.

"The LOA is a document of record supporting the system advanced development. It may be prepared also to support non-system advanced development if the conceptual application to improved or new system can be adequately defined." (1 :2)

"The Required Operational Capability document is the vehicle for securing the Army's commitment to pursue full-scale development and/or procurement of a system."

To go the ROC route, " The system concept will be developed and validated jointly by the materiel developer and combat developer prior to formal commitment by the Army to the need for the system." (1:2)

Although any facet of the upgrading program could have probably been justified for advanced development or full scale development the requirement documentation strategy was actually dictated by factors over which the program office had no control.

The most dominant factor was the existence of the proposed new system which was being funded with advanced development funds. The existence of this new system made it impossible for TRADOC to support full scale development approach for upgrading the existing system. This would have been equivalent to committing to a preferred approach for future air-to-ground rockets.

As far as the Army Materiel Command (AMC) was concerned, the driving aspect was the development status of aircraft fire control program and that of the Advanced Attack Helicopter (AAH). Their position was that there was no need to rush into full scale rocket development if the finished product would sit on the shelf waiting for the fire control and AAH programs to be completed. Also, to conduct the operational testing of the upgraded rocket system or the proposed new system, a prototype fire control system was a minimum requirement. Thus AMC would only support warhead advanced development.

Third, but not the least, was a joint review by the project manager, TRADOC and AMC of the projected advanced and full scale development funds being allocated by Army for aircraft weaponization. This review revealed at that time that there would not be sufficient advanced development funds to support the program. Due to the priority of this non-major program there was no justification for requesting additional funds.

To overcome these hurdles a strategy was jointly developed which would allow the light weight launcher and remote set fuzing efforts to be structured and documented for full scale development. This was because the light weight launcher and fuze could be used with the existing rocket configuration as well as an upgraded version of the system and the new system. The warheads were to be structured and documented for advanced development.

Such an approach did not commit AMC or TRADOC to a premature selection regarding a new or upgraded system. It was compatible with fire control and AAH developments. The strategy was also compatible with the projected funding profiles should upgrading be adopted. Another reason for TRADOC's refusal to consider full scale development for the warheads was that they were required to support full scale development decisions with a Cost and Operational Effectiveness Analysis (COEA). This was not done when there was sufficient data available. The COEA will be addressed more fully under "Systems Analysis."

From the above it can be seen that in upgrading a system a project manager is not only concerned with a requirement but the type of document strategy is vitally important.

Advocacy

Advocacy has been raised because of the numerous ways in which a project manager can create an image of himself and the project.

A Project Manager must avoid creating an impression that he is motivated by vested interests. As in any case a project manager adopts a basic position or premise around which he advocates his system. The basic assumption is that if the project manager does not advocate his own program neither will anyone else.

In this situation a number of advocate roles were possible to adopt. The project manager could structure his advocacy around identification with the basic rocket system. In effect he would be highlighting the upgrading of the system thereby facing the issue on the entire system.

This approach was very rapidly rejected. It would require that attention be focused on the good and bad parts of the rocket system. As has been pointed out the user community appeared to be significantly biased against the antiquated rocket. Strong identification with the existing rocket would only lead to the opinion of a better antique. On the laboratory side of the house a similar situation existed. Development engineers had strong feelings against being intimately associated with an old system. To top it all off, the entire system was not being totally reconfigured, therefore, why force attention to the remaining segments as well as the new ones.

Close identification would also raise the issues of past reputations and apparent limitations. It has been seen that the reputation was perceived in many ways the majority of which were not favorable. The proposed upgrading efforts would be difficult enough to support without interjecting inappropriate impressions. Thus it was important that association with the old rocket be minimized. (Note: Advocacy strategy was being formulated prior to completion of the Baseline Accuracy Test) Another approach would be to attempt to advocate the upgrading program as being equivalent to a totally new item which includes the latest technology. If the user and laboratories were associated with the program in this context, they would be more likely be more responsive. Their responsiveness would tend to stem from an apparent deep desire for new weapons.

Deputy Secretary of Defense Packard touched on this subject in the 1970 House Hearings on Policy Changes in Weapon System Procurement. "Both the user and the developer are anxious to develop the new weapon and they have great incentive to underestimate the cost so that the project will be approved." (8 :7)

Laboratories in particular are anxious to identify with a new program and new technology for this has a direct bearing upon the funds which they receive. However, development of all elements of a system has been criticized in Congress.

> The emphasis on developing all elements for a system as part of a single development project... causes the accumulation in one program of a dangerously high magnitude of risk, from both cost and technology standpoints..." (13 :6)

This approach posed the problem of completely losing connection with the existing system. Such a possibility was not acceptable. The existing system did have an excellent reputation regarding cost control, delivery, and reliability. A production base also exists. These attributes could not be sacrificed.

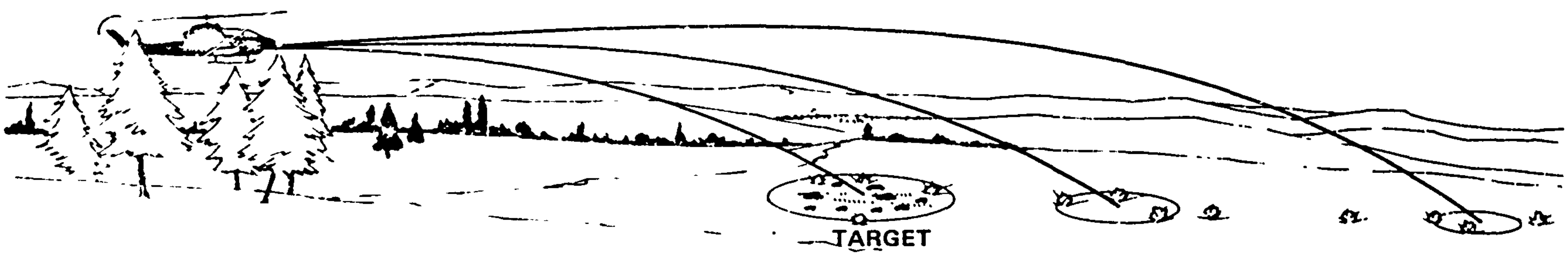
The approach that was selected could be considered a middle of the road approach. This middle of the road approach however, which was the cost accurate indication of what was transpiring.

The project manager would not advocate the system rather be took the position of advocating warhead technology combined with aircraft fire control technology. The rocket system in effect would be the delivery vehicle; the link between these technologies.

He thus became the advocate of technology prudently applied. In all modesty he could point to significant warhead technology advancements for air-to-ground rocketry. In fact some breakthroughs were achieved. The multi-purpose submunition warhead represents such a breakthrough in that delivery of munitions into a target area becomes insensitive to aircraft pitch errors at launch (Figure 2).

O.B. Butler, Vice Chairman of the Board of the Proctor and Gamble Company succinctly stated the benefits of prudently applied R&D. "Many small incremental product and process improvements with a major breakthrough now and then are the R&D goals for sustained success in the market place." (2:7)

Unitary warhead delivery sensitive to A/C pitch errors



Submunition warhead delivery not sensitive to A/C pitch errors

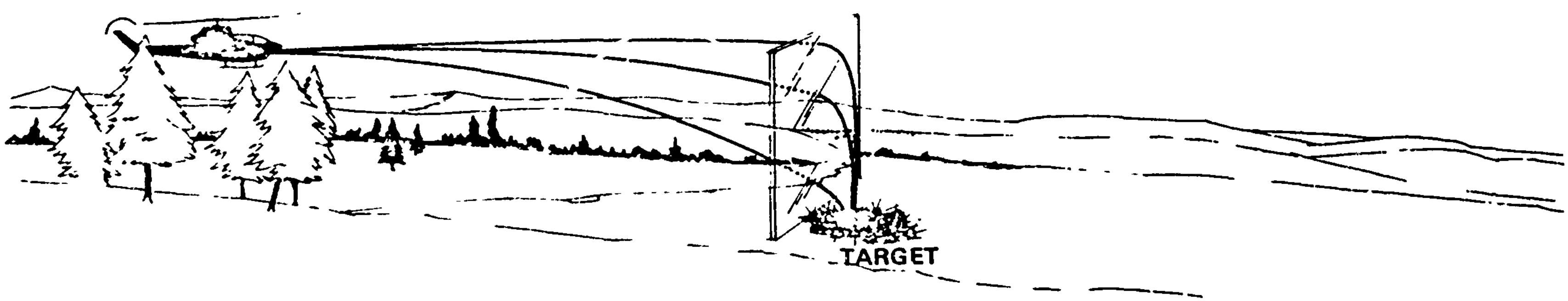


FIGURE 2 Warhead Technology Improves System Effectiveness (10:39)

Such a strategy was compatible with the user's and laboratory's desires to seek newness. There was not a total loss of the positive attributes of the existing system. In addition advocating the program in this manner was in concert with issues raised during Congressional testimony:

> If more emphasis and direction is given to the advancement of the technological base, then the flow of technology would come (into) component and subsystem development developments and subsequently into new systems development or modification of existing systems... (13 :7)

> I would also recommend a return to our former practice of developing components such as armament or engines which would be available off-the-shelf for different programs. Our recent practice of making new engines, radar, guns, and similar equipment new for every different weapon system leads to extreme costs and lengthy development time. (13 : 37)

This advocacy position has met with a great deal of success. Recipients of briefings structured on this basis clearly understood what was transpiring. Most of all, however, the project manager and his entire staff are regarded without exception as an extremely credible organization.

This case has shown that in a situation of attempting to upgrade a system, advocacy becomes a sensitive issue and must be specifically addressed. Whereas, for a new system, the advocacy role is not such a subtle issue.

SYSTEMS ANALYSIS

As stated in the previous section, the project office quickly recognized that systems analysis of free flight aerial rockets lacked the sophistication required to provide a sound data base of decision making. The methodology was correct from a rocket engineering point of view but was believed to be insufficient from an operational viewpoint.

The Baseline Accuracy Test had established the validity of needing to consider more than just the rocket in the analysis. The refined methodology, however, had to be interjected into the decision-making cycle in a manner that would cause the upgrading of the existing system to receive consideration for full scale development.

Reviewing the decision-making process it was seen that TRADOC's Cost and Operational Effectiveness Analysis (COEA) would be the most effective vehicle.

> Cost and Operational Effectiveness Analysis -- A COEA is a study which has a purpose of developing recommended rank orderings of candidate systems for meeting an approved requirement based on meaningful relationships between cost and operational effectiveness. A COEA can be defined as a documented investigation of: comparative effectiveness of alternative means of meeting a requirement for eliminating or reducing a force or mission deficiency; the validity of the requirement in a scenario which has approval of HQ TRADOC and HQDA; and the cost of developing, producing, distributing, and sustaining each alternative in a military environment for a time preceding the combat application. (14 :3)

The COEA route was selected for a number of reasons. First, one of the main objectives of the COEA as cited in TRADOC Reg 11-8 is "all feasible competing systems including those currently in use and those that can result from their modification or product improvement have been compared and that the changes permitted or made necessary in supporting element of the force due to the introduction of the alternative systems have been identified and considered." (14:2)

The policy for the COEA also assures that there is an integration of operational scenarios and considerations throughout the analysis.

Another most significant factor in the COEA process is that all interested parties are involved in the planning and preparation of the analysis. Prior to the analysis they concur with the scenario, input data (both technical and cost), methodology and constraints. This assures that there will be minimal criticism of the results. Charges of bias are eliminated. The overall objective is to provide the decision makers within TRADOC with an objective assessment of weapon systems in terms of performance, cost, and operational considerations.

TRADOC used the COEA as the primary document in their ROC decision making process. Supported by the Army Materiel Systems Analysis Agency (AMSAA), the project manager convinced the CG of TRADOC that the COEA to be done on the proposed new rocket system for entry to full scale development should also include the upgraded version of the existing rocket system.

The direct approach to the CG of TRADOC was considered essential because the new rocket system was rapidly completing advanced development, and was preparing for its COEA. If the upgraded version of the existing system was not included and TRADOC decided to proceed with the new system it would be all but impossible to reverse the decision.

The comparative analysis was conducted. However, it was not limited to just comparing the new system to the existing and upgraded rocket systems. It compared the intermingling of warhead and motor technologies of the upgraded and new rocket systems. These were also compared with varing levels of fire control performance. Although on an individual rocket to rocket basis the new rocket was about two times as effective as the existing rocket, an aircraft could only carry half the number of new rockets as compared to the existing or upgraded versions of the existing rocket system.

Overall, the results of the COEA supported the upgraded version of the existing rocket system. There were a few configuration and target situations in which the new system was better but these were by no means dominant.

From an affordability standpoint the analysis highlighted the fact that it was more cost effective to train pilots and keep them proficient by using the upgraded system. The consequences were that TRADOC decided to approve the upgraded version of the existing system based almost exclusively on their systems analysis known as the COEA.

SECTION V

CONCLUSIONS

It must be remembered that the foregoing discussion was concerned with a non-major project. The correlation of the problems and conclusion to major programs cannot be assumed. There was no attempt to include any consideration of similar situations without other services.

Primarily from personal experience supplemented with various readings, the following conclusions/opinions were formed regarding the difficulties in trying to upgrade an existing system which is faced with a competing new system.

1. Basic Army policy supports exploitation of unrealized growth within existing systems.

2. Advancement of technology is essential to the Army's evolutionary development policy.

3. There exists an inherent desire for the newest system possible especially by the user and laboratories.

4. Subjectivity is a greater obstacle to upgrading a system than it may be in initiating a new system.

5. Factors such as advocacy which are regarded as an asset when associated with a new system can be counterproductive when associated with system upgrading if not tailored to the situation.

6. As always but especially when trying to promote the upgrading of his system, credibility and openness are a PM's greatest assets.

7. A project manager must keep abreast of advancing technology and take the initiative to develop the evolutionary potential of his system.

8. Systems analysis, due to its key role in the decision making process, cannot be compromised with the use of over-simplified assumptions.

9. The creation of the COEA concept by the Army is a significant advantage to the decision making process in that it allows for maximizing the exploration of alternate approaches to satisfying a requirement, i.e., competition can be maintained at a highly visible level until full scale development.

10. The Army's COEA is in effect the last opportunity available to interject a competitive system into the decision making process.

11. The COEA offers the potential of acting on an excellent control function in a manner similar to that of independent testing in the systems acquisition process.

SECTION VI

RECOMMENDATIONS

On the presumption that there is an active initiative to significantly upgrade existing systems as opposed to proliferate new systems the following recommendations are offered. The recommendations assume that an upgraded system would fulfill requirements as well as a completely new system otherwise the new system should be pursued.

1. Since laboratories are usually the springboard of new ideas, a means of incentivizing these laboratories may be worthwhile pursuing to stimulate their activities to prudently apply technology to upgrading systems.

2. Long range planning documents which forecast the phaseout of existing systems and introduction of new systems should be required to include justification of the new system in terms of old system deficiencies as well as defining what has been considered to upgrade the existing system.

3. Challenges to systems which have not entered full scale development should be encouraged.

4. In the decision-making process proponents/custodians of existing systems should concur in the inability of their system to be upgraded to meet new requirements.

5. Project managers within their charter could be held accountable for initiating prudent and continuing efforts to provide the maximum exploitation of his system.

6. The acquisition cycle should formally recognize the upgrading process in a manner that would give it equal rigor to existing acquisition phases.

7. Early in the acquisition cycle systems analysis methodology should reflect operational environments and constraints as accurately as possible.

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DEFENSE SYSTEMS MANAGEMENT SCHOOL

STUDY TITLE:

TODAY'S WEAPONS -- TOMORROW'S REQUIREMENTS
Upgrading Existing Systems vs New System Development
-A Case in Point-

STUDY PROJECT GOALS:

The overall goal was to show that the Army's Cost and Operational Effectiveness Analysis (COEA) policy provides an effective avenue in the acquisition process for bringing attention to and comparing an upgraded system with a new system. Specifics leading up to the value of the systems are the delineation of unique problems faced when upgrading a system and the need for systems analysis to reflect the "total" system.

STUDY REPORT ABSTRACT:

By using an actual case history of a program with which the author was associated as a framework, this paper delineates some unique management problems faced by a project manager in an attempt to upgrade his system in the face of a new system.

With problems defined, the project manager's solicitations and rationale to achieve acceptance of system upgrading are presented.

It shows that significant hurdles to system upgrading are generated by subjective and administrative problems which are not usually found in the acquisition of a new system.

The report shows how the project manager confronted these problems and how the Army's Cost and Operational Effectiveness Analysis (COEA) policy provided the avenue for achieving visibility for the potential upgraded system.

The report concludes that: (1) it is more difficult to gain acceptance of an upgraded system than it is for a new system, (2) advanced research and development is as essential for upgrading systems as it is to create new systems, (3) systems analysis must reflect technical and operational considerations for an accurate system assessment and (4) the Army's acquisition policies, in particular the COEA provide channels for bringing forth the acceptance of upgraded systems.

KEY WORDS MATERIEL DESIGN AND DEVELOPMENT REQUIREMENTS MANAGEMENT
PROGRAM MANAGEMENT ROC
TECHNOLOGICAL FORECASTS
KEY WORDS: PRODUCT IMPROVEMENT COEA

NAME, RANK, SERVICE	CLASS	DATE
Charles J. Supko GS-12 DAC	PMC 76-1	12 May 1976